

A study of the relationships among university students' attitudinal variables and academic achievement in statistics

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ABSTRACT

This study investigated the relationship among university students' attitudinal variables and their achievement in statistics. The study also examined the relative contribution that each variable makes to their academic achievement. The study sample comprised 96 university students. Data were collected using a self-designed questionnaire. The reliability coefficients of the various subscales of the piloted questionnaire exceeded 0.70 and were found good to use. The analysis of the data showed a significant positive correlation among three of the students' attitudinal subscales, namely interest towards statistics and academic achievement ($r=0.315$, $p=0.001$), motivation to study the subject and academic achievement ($r=0.375$, $p=0.000$) and usefulness of statistics and academic achievement ($r=0.268$, $p=0.004$). However, there was a positive low, but insignificant, correlation between anxiety and academic achievement ($r=0.218$, $p=0.084$). Further analysis, using multiple regression, showed that all the students' attitudinal variables, except anxiety, made a significant relative contribution to their academic achievement in statistics. It was recommended that lecturers should help to develop students' interest and motivation, educate them on the usefulness of statistics, and also, consciously try and reduce university students' anxiety towards statistics.

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1. INTRODUCTION

Statistical knowledge plays a significant role in the life of every university student as it is applied in reporting their research work [1], [2]. Statistical processes, which share many characteristics with research, collect and analyse data to explain a phenomenon [3]. This makes statistics an indispensable tool for writing a research project. According to Arumugam [4], higher education institutions offer statistics as a prerequisite to other courses, such as research methodology. Maat *et al.* [1] support this idea because almost all social and pure science programmes in university include at least a course in statistics to equip students with basic statistical knowledge for research purposes. Thus, the teaching and learning of statistics plays a central role in the academic activities of university students' education and must be given critical attention.

Not only in academia are the benefits of statistics education felt. Knowledge of statistics is used to solve problems in our environment. Many activities in daily life expose us to a wide range of situations where statistical knowledge is required to make decisions. This makes statistics useful in our life and place of work [5]. For example, in industry, management's decision to improve upon services rendered to customers depends on the data

collected about existing services to identify possible deficiencies per the customers' view. Also, the quality control division of industries often collects data about how to ensure the quality of their products [6]. These decisions are based on the knowledge-base of the statisticians. The small-scale trader must make a decision about the required goods to stock in his/her shop to meet the customers' needs and serve them effectively. In other words, what type of items or goods do customers buy most? Such a decision is very important in order not to stock the shop with items that have low demand or patronage. In this regard, Maat *et al.* [1] asserts that statistical knowledge should not only be restricted to students, but to the general public, to educate them on statistical concepts that are used in daily life. The authors add that people would be able to extract the needed information from given data when they have been given a good statistics education.

Considering the benefits of statistics, early exposure to statistical concepts is very important. For example, in the Ghanaian education system, as in many other countries, statistics education begins from basic school education through secondary education to the tertiary level. The probable rationale is to equip them with basic statistics knowledge to appreciate its usefulness and application to certain tertiary education courses to develop their interest in learning [7]. Akour [8] asserts that the purpose of statistics education is to prepare students to engage in statistical reasoning and use it to solve problems in real life.

Despite the benefits of statistics in academia and daily life, research shows that most university students approach studying statistics with high degree of fear [1], [2]. Many students, particularly from non-mathematics programmes, face difficulties in understanding basic statistical concepts. Larbi [5] claims that university students fear, or dislike of statistics probably results from the difficulties faced in learning mathematics in secondary school. Maat *et al.* [1] add that students' low interest in learning statistics could be attributed to their inability to use the appropriate mathematical symbols in statistics discourse. This and many other factors result in students' low academic performance.

Research attributes some factors that support students' achievement to the teacher factor, the learning environment, and parents [9]. Other studies have investigated students' attitudes towards statistics [10], [11], with few focusing attention on some attitudinal variables such as anxiety and achievement in statistics [1] and motivation and academic achievement [12]. However, various attitudinal variables of university students such as interest, motivation, usefulness, anxiety, and their achievement in statistics have not fully explored. It is noticed that studies on the various attitudinal variables are less regarding students' fear for statistics. This implies that there is inadequate research for guiding students' development of positive attitudes towards statistics. As a way of developing university students' interest in the subject, it will be interesting to collect data from student attributes and use it for statistical lessons to help them realise the immediate importance of statistics and how their attitudinal variables relate to their achievement in the subject. Findings of this study will serve as empirical evidence to guide students' development of positive attitudinal variables towards the study of statistics and a point of reference for further research in modeling students' characteristics and achievement in various disciplines.

Therefore, the goal of this study was to investigate the relationship among university students' attitudinal variables (interest, motivation, usefulness, and anxiety) and their statistics achievement and to identify the relative contributions these variables make in their achievement in statistics. The study aimed to address the following research questions:

- What significant relationship exists among university students' attitudinal variables (interest, motivation, usefulness, and anxiety) and their academic achievement in statistics?
- What is the relative contribution of these variables in predicting students' academic achievement in statistics?

2. LITERATURE REVIEW

2.1. Usefulness of statistics

Larbi [5] asserts that statistics is useful for all students irrespective of career choice. Statistics knowledge helps to make accurate and informed decisions. Notably, it is use in university students' research work, where they need sound and in-depth knowledge of statistics to analyse and extract the information from the data and communicate its findings in a scholarly and scientific way. Thus, statistics education cannot be underestimated. Songsore and White [13] explain the usefulness of statistics as students' ability to identify relevant and important aspects of "their personal and professional lives", including future careers. The authors add that statistics is useful in daily life and beyond the work place. Songsore and White [13] review of several studies shows that whilst most studies focusing on attitudinal factors report similar findings, there seems to be a decrease in value (usefulness) and interest. The authors conducted a study with the focus on students' interest and perceived usefulness of statistics. Data were collected from undergraduate students who had completed a first-year online course in introductory statistics. Results showed that the students valued statistics topics only if they could apply it to their daily activities and in their academic and career related choices. Previously, Ashaari *et al.* [10] attributed students' dislike for statistics to the fact that it is not useful to their programme of

study, as well as their future careers. Students are motivated to learn and retain if they know that what they are learning is worthwhile [14]. Studies show that students perceived usefulness of a subject correlates with their academic achievement [15].

2.2. Undergraduates' interest in statistics

Interest plays a significant role in students' learning. Ashaari *et al.* [10] claim that students show interest in learning something when they have a positive attitude towards that phenomenon. Literature shows that students' academic performance is related to interest [12]. However, many students show little interest in learning statistics because they consider statistical concepts very difficult to learn [16]. Songore and White [13] assert that students' interest in statistics is related to their willingness to study and communicate statistical information and their readiness to use the knowledge in life. Ashaari *et al.* [10] conducted a study in which data were collected from first year students who were enrolled in a statistics and probability course. The authors used [8] survey of attitude towards statistics (SATS) which assessed both students' cognitive and non-cognitive factors to collect data on the students' attitude. The results showed that the interest component of the attitudinal subscales towards statistics was moderate. The authors assert that students learn statistics with interest if they know its usefulness in their professional careers. Larbi [5] supports this claim when he adds that one's interest in a phenomenon shapes his/her behaviour towards it.

Research shows that students' interest in a course of study relates positively with achievement [15]. For example, Melad [15] study in which data were collected from 560 students enrolled in a business statistics course at the university to investigate the relationship between the students' attitude and their achievement, results showed that the interest subscale of the attitudinal variables significantly correlated with their statistics achievement. Other researchers who found a significant positive relationship between interest and academic achievement are [12], [17].

2.3. Anxiety towards statistics

Several factors influence students' learning gains in statistics. According to Maat *et al.* [1], anxiety is one of the critical factors among students' elements that affect learning. In this regard, researchers have focused much attention on students' anxiety towards statistics [18]. Malik [19] defines statistical anxiety as "the feeling of anxiety [worry or nervousness] encountered when taking a statistics course or doing statistical analyses which are to gather [data], process and interpret". Such fear of statistics hinders students' learning and understanding of statistical concepts [20].

Due to students' dislike for statistics, even at university, those who have the chance to choose statistics for a semester (though required for graduation) often postpone taking this course till they must write a research project in the final year [21]. This fear goes a long way to affect their academic achievement. Liu *et al.* [21] found in a study that there was a negative relationship between university students who possessed high statistics anxiety and their performance. Also, researchers have identified a negative effect of students' statistics anxiety on their learning and performance in the course [22], [23]. As a result of statistics anxiety, about 80% experience a decline in their academic performance by taking a course in statistics [23]. As indicated earlier, this fear of statistics at the university may have resulted from an early or secondary school mathematics course [5]. For example, a study by Mutegi *et al.* [24] found a significant negative relationship between mathematics performance and anxiety. Also, Siaw *et al.* [25] found a weak positive correlation between students' level of anxiety and their performance in mathematics. Maat *et al.* [1] studied statistics anxiety and achievement of university students. The authors collected data from 199 students using a 51-item statistical anxiety rating scale. The analysis showed that the university students' statistical anxiety was moderate.

2.4. Motivation in studying statistics

Motivation is another factor that affects how one reacts towards a phenomenon. It is the act of arousing and sustaining one's interest towards a particular phenomenon. One major factor that drives or propels students towards achievement is motivation for academic achievement [12]. Erten [26] asserts that motivation stimulates people to pay attention in class to achieve a desired goal. It is the underlying reason for people's behaviour and explains why they behave in a particular manner. Erten [26] claims that motivation, which could be internal or external, correlates with both learning and academic performance. Bakar *et al.* [17] studied the relationships among university students' achievement motivation, attitude, and academic performance. The purpose of the study was to identify relationships among the variables and used the descriptive correlational research design. Cluster sampling was used to select 1484 university students from different faculties. Results showed that there was a positive correlation between their attitude towards learning and achievement motivation, attitude and academic achievement. However, there was a low negative correlation between achievement motivation and academic achievement. Similarly, Walker *et al.* [27] also found a significant and positive relationship between students' motivation and academic achievement.

3. METHOD

3.1. Research design

Guided by the purpose of the study which aimed to investigate the relationship among students' attitudinal variables, this study adopted the positivist research paradigm and hence, was conducted following the quantitative approach. The descriptive correlational research design was used in this study due to the researchers' interest in determining and explaining the relationship among the variables of interest (students' attitudinal variables and academic achievement) without any manipulation of the research subjects [28]. In addition, there was the desire to describe the relative contribution of the students' attitudinal variables to their achievement in statistics.

3.2. Study population

The study population was all first-year students in the Fashion and Textiles Department of the Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development. The entire population was 239. As it is in the design of many other university programmes, the students were required to study statistics to equip them with the basic statistical knowledge they would need for possible application in their programmes of study, as well as writing their research project [1].

3.3. Sample and sampling procedure

The study sample was 96 students selected from one of the two classes from which most of them agreed to take part. The purpose of the study was explained to them and their participation was sought voluntarily. Of the 115 students in the class, 96 indicated their willingness to be involved in the study. Also, they were assured of confidentiality of the responses or answers that they provide. These were students who had registered for statistics and probability as part of the semester courses of the 2022/2023 academic year.

3.4. Data collection instrument

Data were collected using a self-designed instrument. The first instrument was a questionnaire which consisted of 28 closed-ended statements. Each of the statements was followed by the 4-point Likert scale responses which ranged from strongly agree, agree, disagree and strongly disagree. The statements were based on literature [5], [8] and focused on four subscales, namely interest, motivation, usefulness, and anxiety. This instrument was used to obtain data about the respondents' attitude towards statistics on the various subscales. The second instrument was a statistics achievement test (SAT). The SAT consisted of 40 objective questions and one essay question which were constructed based on the statistical concepts covered in the entire semester lessons. As non-mathematics education students, the learning outcome of the course was for the students to demonstrate knowledge and understanding of basic statistical concepts that will be needed in their programme of study and to conduct research as part of the programme requirement for graduation. Some of the statistical knowledge assessed on the SAT were their understanding of basic statistical concepts, estimating measures of central tendency, dispersion, and relative position. Others were correlation and simple regression, probability and counting rules and most importantly to interpret the statistical measures estimated.

3.5. Validity and reliability of the instrument

The quality of the questionnaire was determined by ensuring the validity and reliability of the items through pilot test. The item/content validity for ensuring that each item measures what it was purported for was ensured by giving the questionnaire to two colleague lecturers to assess each item in terms of precision and ambiguity. The questionnaire was then pilot tested and the data were used to assess the internal consistency of the items in the various subscales. The reliability coefficients of the attitudinal subscales in the questionnaire are shown in Table 1.

Table 1. Reliability coefficients of sample items of the attitudinal variables

Variables	Sample of variable item	Reliability coefficient
Interest	Statistics in an interesting course	0.72
Motivation	Learning statistics is stimulating	0.73
Usefulness	Statistics can be applied in other courses	0.70
Anxiety	I do not feel comfortable at statistics lessons	0.70

3.6. Data collection procedure

On the agreed date for data collection in one of the statistics lessons, the researcher(s) administered the questionnaire to the students. They were allowed time to respond to the items/statements by indicating their level of agreement to each. The questionnaires were collected from the students before leaving the class. The

questionnaire elicited data on the students' attitudinal variables whilst data on their statistics achievement were obtained using their score at the end of the semester SAT.

3.7. Method of data analysis

Prior to analysis, the data were screened before coding. The 4-point Likert scale responses were coded such that positive items were assigned values from strongly agree-4 to strongly disagree-1 whilst that of negative items were reversed. The data were then entered into SPSS version 24 and analyzed. The 4-point Likert scale was used to enable each student to choose a response (favourably or not) to each of the questionnaire items. Research question one was analyzed using the Pearson product moment correlation whilst research question two was analysed using the multiple regression analysis. The students' attitudinal variables, namely interest, motivation, usefulness, and anxiety, were used as independent variables and the dependent variable was their statistics achievement.

4. RESULTS AND DISCUSSION

4.1. Relationships among attitudinal variable and statistics achievement

Research objective one sought to find the relationship among the attitudinal factors and their achievement in statistics. This was found by subjecting the data to correlational analysis. The results are presented in Table 2. The results in Table 2 show that the students' achievement score in statistics significantly correlated with their interest in statistics ($r=0.315$, $p=0.001$), motivation to study the subject ($r=0.375$, $p=0.000$), and usefulness of statistics ($r=0.268$, $p=0.004$). The finding supports that of Walker *et al.* [27] who reported that there was a significant positive relationship between students' motivation and academic achievement. The positive significant relationship between these two constructs shows that as university students are motivated, either internally or externally, to study statistics, it is likely to contribute to their learning gains. However, the finding of this study on motivation is in contrast to that of Bakar *et al.* [17] whose study found a low and negative correlation between students' motivation and academic achievement.

This study also found that there was a significantly positive correlation between the university students' interest in learning statistics and its usefulness and their achievement in statistics. These findings support that of Melad [15] who studied the relationship between university students' attitude and their achievement in statistics and found interest and usefulness (value) among the attitudinal subscales to positively correlate with their statistics achievement. Also, these findings concur with that of other researchers who found a significant positive relationship between these constructs and students' academic achievement [12], [17]. The findings further support [10] assertion that students' interest in learning develops when they know the usefulness of the subject being learned and its applicability to life and future endeavours. According to Larbi [5], one of the major factors that shape students' disposition towards a phenomenon is interest. One's disposition towards a phenomenon gets developed through a growing interest in that phenomenon. It was found in this study that the students showed interest in learning statistics and also found it useful which probably resulted in a positive and significant relationship with their achievement score at the end of semester SAT.

Another finding in this study was that there was a weak positive correlation between participants' anxiety and their statistics achievement, though the relationship was not significant ($r=0.218$, $p=0.084$). This result contradicts the findings of other studies that have found that university students anxiety correlates negatively with their academic achievement [21]. Study of Liu *et al.* [21] found this result among undergraduates with high levels of statistics anxiety. Thus, a possible interpretation to the low positive correlation (though not significant) obtained in this study could be that the study participants may have experienced a low level of anxiety towards statistics. The participants in this study were university students and these results may be due to their current level of study and probable methodological differences as opined by Bakar *et al.* [17].

Issues of statistics anxiety are of great concern to statisticians and statistics educators. Any level of student worry, fear or anxiety experienced towards statistics often affects their work output in classroom participation. Anxiety can affect students' learning in many ways, such as, how they ask questions for clarify in class and deciding the most appropriate statistical techniques to use in a task, either in class work or in examination [1].

Table 2. Correlation among students' attitudinal variables and academic achievement

No.	Variables	1	2	3	4	5
1	Academic performance	1				
2	Interest towards statistics	0.315**	1			
3	Motivation to learning statistics	0.375**	0.736**	1		
4	Usefulness of statistics	0.268**	0.446**	0.499**	1	
5	Anxiety towards statistics	0.218*	0.613**	0.607**	0.568**	1

Note: **Correlation is significant at 0.05 and *Correlation is not significant at 0.05.

4.2. Regression analysis

To understand the attitudinal variables that influence the students' achievement gains, further analysis was conducted with multiple regression using students' interest, motivation, usefulness, and anxiety to statistics as the independent (predictor) variables and their achievement score as the dependent (outcome) variable. The aim was to determine which of these variables significantly predicted their achievement in statistics. To ensure that no violation of the assumptions of linearity, multicollinearity, normality and homoscedasticity occurred, preliminary analyses were conducted on the data. The analysis showed that in all there was a significant effect of the students' attitude on their statistics achievement $F(4, 92)=4.250, p= 0.003$ ($p<0.05$). Three of the variables were found to significantly contribute to their achievement in statistics. These are interest, motivation and usefulness. To find the relative contribution of the variables, their significant effect was assessed. This is presented in Table 3.

Results in Table 3 show that the predictor variables were significant based on the F-ratio of 4.250 with $p<0.05$. The unique contribution of each of the independent or predictor variables was determined by the standardized coefficients for the variables. The independent variable, which has the highest beta value, made the most relative contribution to the prediction model. These values are shown in Table 4.

The relative contribution effect of attitudinal variables on the students' achievement was assessed using the three predictors. Of these, the students' motivation to study statistics made the largest significant contribution ($\beta=0.298, p<0.05$) to the prediction of their academic achievement in statistics. This was followed by the usefulness of statistics ($\beta=0.131, p<0.05$), and then the students' interest in studying statistics ($\beta=0.096, p<0.05$). However, the students' anxiety towards the study of statistics was found not to make any potential contribution to the prediction of their academic achievement.

The finding of motivation being the most significant contributor to university students' academic achievement in statistics contradicts the finding of Bakar *et al.* [17] whose study found academic motivation to make the lowest contribution to academic achievement among other variables such as attitude, peer influence, gender and ethnic group. Bakar *et al.* [17] found their result quite surprising because, according to them, motivation is generally known to make a strong correlation with and contributes to students' academic achievement in statistics [12].

Usefulness of statistics was also found to contribute significantly to university students' academic achievement. This finding corroborates [14]'s finding that students learn and retain through time a richer recall of it when they know the worth of what they are learning. Literature shows that when students know the usefulness of statistics and its application to their daily lives and careers, it makes them respond positively in terms of learning which is reflected in their achievement [10], [5]. For this reason, researchers [29], [30] assert that teachers should constantly stress the usefulness of statistics and its relevance in future careers during the teaching and learning of statistics to guide students' decision making and perceptions made about it.

On the other hand, statistics anxiety was found not to make any significant contribution to the participants' statistics achievement. This finding corroborates that of Maat *et al.* [1] who also found that statistical anxiety among the constructs they investigated made no significant contribution to the students' academic success in statistics.

Table 3. Contribution of the attitudinal variables to achievement

Model	Sum of squares	df	Mean square	F	Significance
Regression	1661.233	4	415.406	4.250	0.003
Residual	8991.923	92	97.738		
Total	10,653.546	96			

Table 4. Relative contribution of the attitudinal variables to achievement

Variables	Unstandardized	Coefficients	Standardized coefficients	t	Sig.
	B	Std. error	Beta		
Constant	12.729	7.369		1.727	0.001
Interest	0.240	0.373	0.096	0.644	0.000
Motivation	0.556	0.281	0.298	1.976	0.000
Usefulness	0.366	0.334	0.131	1.094	0.000
Anxiety	-0.353	0.499	-0.097	-0.706	0.065

5. CONCLUSION

The study investigated the relationship between students' attitudinal variables and their academic achievement, and the contribution efficacy of students' attributes, namely, interest, motivation, usefulness, and anxiety, on their academic achievement in statistics. The findings of this study show that among the four students' variables studied, three of them were found to be significantly and positively correlated to their

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academic achievement. These variables were motivation, interest and usefulness. A possible interpretation is that, as students make a conscious effort to appreciate the usefulness of statistics, they develop interest in learning statistics and become self-motivated to learn the subject, this gives a great potential result in their academic achievement in statistics. Also, anxiety was found not to significantly correlate to academic achievement. Another conclusion, based on the findings of this study, is that the three variables, namely interest, usefulness and motivation, were found to make relatively significant contributions in predicting the students' academic achievement with motivation making the largest impact of all.

For educators to see significant improvement in university students' achievement in statistics, it is recommended for lecturers, who play a significant role in student attitudinal development, to use appropriate interactive teaching methods that can help create and sustain the students' interest and motivation in studying the subject. It is also important that lecturers guide students to appreciate the usefulness of statistics in academia and daily life. It is suggested that future research should focus on ways of improving students' interest and motivation towards statistics.

Several factors influence students' achievement in statistics. Teachers' awareness of such factors can enable them to incorporate those factors into teaching and learning with the aim to develop among students those which have positive effect on achievement, generally shown by research, as well as to take steps to reduce those with a negative effect. For example in this study, students' interest, motivation and usefulness of statistics were found to correlate significantly to their academic achievement. In this regard, teachers can use several mechanisms to develop students' interest, motivate them to learn statistics and to share with students the benefits of statistics in both academia and in daily lives. Students make conscious effort to learn and understand when they know the usefulness of what is being learned. Statistics applies to many fields or courses of study in undergraduate programmes. Students would need a sound and adequate knowledge of statistics to analyze the data obtained in writing their project work and to draw appropriate findings. For students to realise the immediate usefulness of statistics, it can be proposed that instead of calculating statistical concepts using data that students know nothing about which can result in abstractness of what is being learned, there can be a practical data generation from the students' attributes such as heights, ages, weights, marks obtained in a test or examination, learning materials in their possession, day of birth, and many more. Determining the mean, mode and median (measures of central tendencies), range, standard deviation, variance (measures of dispersion), relationships among these variables, and using some of these variables to predict academic achievement, can make them realise the immediate importance of statistics, develop their interest in learning and be highly motivated to learn. The current research shows these factors to be significantly correlated to and made a relative contribution to predicting students' academic achievement in statistics.

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C : Conceptualization

M : Methodology

So : Software

Va : Validation

Fo : Formal analysis

I : Investigation

R : Resources

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O : Writing - Original Draft

E : Writing - Review & Editing

Vi : Visualization

Su : Supervision

P : Project administration

Fu : Funding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

INFORMED CONSENT

We have obtained informed consent from all individuals included in this study.

DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author, [EL], upon reasonable request.

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